

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
21 May 2004 (21.05.2004)

PCT

(10) International Publication Number  
**WO 2004/042949 A1**

(51) International Patent Classification<sup>7</sup>: **H04B 1/76, 1/10**

(21) International Application Number:  
PCT/AU2003/001484

(22) International Filing Date:  
7 November 2003 (07.11.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
2002952566 7 November 2002 (07.11.2002) AU

(71) Applicant (for all designated States except US): **DSPACE  
PTY LTD** [AU/AU]; Innovation House, First Avenue,  
Technology Park, Mawson Lakes, SA 5095 (AU).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **MICHAEL, Robert,  
Peake** [AU/AU]; Innovation House, First Avenue, Technol-  
ogy Park, Mawson Lakes, SA 5095 (AU).

(74) Agent: **ALLENS ARTHUR ROBINSON PATENT &  
TRADE MARKS ATTORNEYS**; Stock Exchange Cen-  
tre, 530 Collins Street, Melbourne, VIC 3000 (AU).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU,  
AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR,  
CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD,  
GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR,  
KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN,  
MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU,  
SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA,  
UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

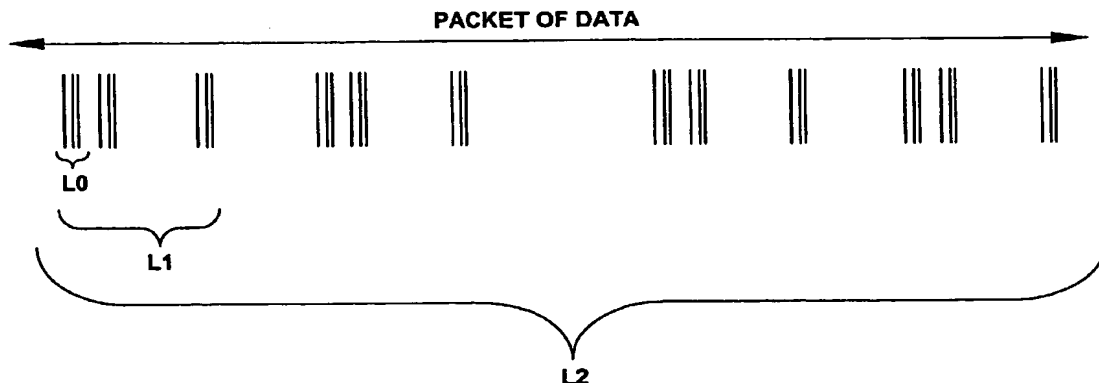
(84) Designated States (*regional*): ARIPO patent (BW, GH,  
GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),  
Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),  
European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,  
ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE,  
SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA,  
GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guid-  
ance Notes on Codes and Abbreviations" appearing at the begin-  
ning of each regular issue of the PCT Gazette.

(54) Title: **PILOT SYMBOLS IN COMMUNICATION SYSTEMS**



(57) Abstract: This invention relates to signal processing in telecommunications, particularly but not exclusively for use in wireless TDMA systems. In particular, the invention concerns methods for use in communication systems making use of pilot symbols. The invention provides a method of placing pilot symbols in a data stream for telecommunication systems, wherein the pilot symbols are spaced in time using a range of different intervals between symbols. The intervals between the pilot symbols are substantially fractal in nature, the distribution of pilot symbols involving repetitions of irregular groupings of pilot symbols in the data stream. Preferably, the irregular groupings of pilot symbols are irregularly spaced in the data stream. The invention also provides a method and means for acquiring the time and frequency offset of a packet of data by using pilot symbols distributed within the packet as defined above.

# INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/AU03/01484**

## A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. <sup>7</sup>: H04B 1/76, 1/10

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
WPAT, ESP@CE, USPTO and Keywords (PSAM, pilot, symbol, non-uniform) and similar words.

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/0136176 A1 (Abeta et al.) 26 September 2002 See paragraphs 32 - 39 and 46 - 51 and figure 3	1 - 3, 8 - 10
X	US 2002/0031189 A1 (Hiben et al.) 14 March 2002 See paragraphs 19 - 21, 27, 33 - 39, 44 and figures 3 and 5 - 10	1 - 5, 8 - 10
X	Lo, H., Lee, D., Gansman, J.A., 'A Study of Non-Uniform Pilot Spacing for PSAM', IEEE 2000, Proceedings ICC International Conference on Communications, Volume 1, 18-22 June 2000, pages 322-325. (sourced from the Internet at <a href="http://www.enee.umd.edu/~jeromeg/Pubs/00853168.pdf">http://www.enee.umd.edu/~jeromeg/Pubs/00853168.pdf</a> ) see abstract, page 323 section III, page 324 section IV and figure 1	1 - 5, 8 - 10

☒ Further documents are listed in the continuation of Box C

☒ See patent family annex

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search  
4 December 2003

Date of mailing of the international search report  
15 DEC 2003

Name and mailing address of the ISA/AU  
AUSTRALIAN PATENT OFFICE  
PO BOX 200, WODEN ACT 2606, AUSTRALIA  
E-mail address: [pct@ipaustalia.gov.au](mailto:pct@ipaustalia.gov.au)  
Facsimile No. (02) 6285 3929

Authorized officer  
**R.W.J. FINZI**  
Telephone No : (02) 6283 2213

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU03/01484

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 98/44644 A1 (MOTOROLA INC.) 8 October 1998 See whole document	1 - 20
A	US 5712877 A (Ho et al.) 27 January 1998 See whole document	1 - 20

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU03/01484

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	2002136176	AU	22278/01	CA	2362418	EP	1158709
		JP	2001197037	WO	0150655		
US	2002031189	AU	71726/01	CA	2412387	EP	1307991
		GB	2385247	US	6424678	WO	0211331
		WO	02058305				
WO	9844644	AU	61645/98	EP	0972348	US	5848357
US	5712877						
							END OF ANNEX